500 DIRECTOR OF APPLIED ENGINEERING AND TECHNOLOGY (AETD)

In concert with GSFC strategic initiatives, the fundamental responsibilities of the AETD are to:

- Provide the full range of engineering discipline expertise needed to enable end-to-end conceptualization, development, and use of earth and space science missions, including the delivery of appropriate science products.
- Provide leadership and vision to advocate and implement a broad range of advanced technology activities in appropriate discipline areas in order to meet current and future space and earth science mission needs.
- To fulfill these responsibilities the directorate provides expertise in the following engineering skill areas: information systems; electrical systems; mechanical systems; guidance, navigation and control; and instrument technology.

These areas work closely together to enable the definition, development and use of scientific instruments, flight platforms, ground systems, and science data processing systems.

The Directorate provides and advances discipline expertise to implement all phases of a product life cycle from germination of the measurement concepts within the science laboratory, through mission definition, design, manufacture, integration, test, operation, and processing of the resultant data. Each area is responsible for infusing improved processes and technology products throughout the life cycle to improve system performance and better enable future missions.

In order to maintain the capability to fulfill its fundamental responsibilities for mission support and technology development, each skill area provides and maintains appropriate facilities, laboratories, analytic tools, and expertise.

The Directorate provides engineering and technology expertise to other Center elements as required. Additionally, the Directorate is in charge of operating the Integrated Design Centers (IDC). The IDC's consist of the Integrated Mission Design Center (IMDC) and the Instrument Synthesis and Analysis Laboratory (ISAL).

The Directorate interacts with the Space and Earth Science Directorates to plan appropriate technology activities that are responsive to future science mission needs. Those technology activities are implemented both directly by AETD and through cooperative activities with outside organizations.

In fulfilling Agency and GSFC strategic initiatives, engineering capability is also

provided to other NASA centers, other government agencies, industry, and academia. Partnerships are forged with this same set of external organizations to cooperatively fulfill the directorate's responsibilities where appropriate. In addition, the directorate proactively works to transfer technology to the private sector, as well as to foster broad community outreach.

501 APPLIED ENGINEERING & TECHNOLOGY DIRECTORATE BUSINESS MANAGEMENT OFFICE

Responsible for the administration and management of all AETD resources in support of the Directorate's institutional and programmatic objectives. These responsibilities include financial planning, budgeting, budget execution, resource analysis, and overall financial management support to all the functional Centers in the Directorate.

Responsible for the business management support to the AETD. These responsibilities include programmatic and institutional manpower planning and analysis, development of tools to assess the availability of the correct manpower skills and to simulate different deployment scenarios to support new business activities, and travel and training budget preparation and tracking.

Responsible for the implementation of full cost accounting within AETD.

Provides leadership and coordination of all AETD outreach and training initiatives.

530 Systems Engineering and Advanced Concepts Division

The Systems Engineering and Advanced Concepts Division (SEACD) leads the development of advanced mission concepts and provides the core capability of end-to-end systems engineering for programs, missions and projects including innovative concepts, system architectures and systems for new missions, technologies and concepts. The Division develops implementation and risk mitigation strategies for the infusion of technologies, ensuring that systems technology advancements are carried from concept through final design. The SEACD manages Goddard's implementation of advanced engineering environment initiatives and architects the strategic planning and implementation of advanced engineering tools, capabilities environments and facilities. The SEACD also serves as GSFC's liaison to the Agency's work in advanced engineering environments and capabilities. These facilities include the Integrated Mission Design Center (IMDC) and the Instrument Synthesis and Analysis Laboratory (ISAL) that provide interdisciplinary tools for rapid modeling, design, analysis, simulation and costing of missions and instruments. The SEACD also

performs technical systems engineering and tradeoffs across the full life cycle for NASA Enterprise and external customers. The missions include Space and Earth science as well as enabling technologies.

531 **Systems Engineering Services and Advanced Concepts Branch**

The Systems Engineering Services and Advanced Concepts Branch provides fundamental systems engineering services to the entire Division and leads the development of advanced mission concepts. These fundamental services include consultation and services to study/initiative and project teams from a core staff of senior advisors and mentors, leadership and support to Agency and GSFC advanced concept development initiatives, services and support to proposal and concept development teams, support to Agency review panels, liaisons to Enterprise developments and support to training and skills development initiatives. The Branch provides feasible mission concepts from partnership development, requirements generation and systems architecture development through the development of comprehensive preliminary mission concepts. The SEAC Branch also provides advanced systems engineering services to the SEACD and the science and engineering directorates. The SESAC Branch also offers a comprehensive portfolio of services in Information Based Systems Engineering, including consultation to project teams, development of systems engineering tools and interdisciplinary tool sets, as well as the development and deployment of collaborative environments and capabilities and capabilities for NASA and GSFC project teams. The SESAC Branch also manages Goddard's implementation of advanced engineering environment initiatives and architects the strategic planning and implementation of advanced engineering tools, capabilities environments and facilities. These facilities include the Integrated Mission Design Center (IMDC) and the Instrument Synthesis and Analysis Laboratory (ISAL). The branch serves as the GSFC's liaison to the Agency's work in advanced engineering environments. The SESAC Branch also serves as the science/customer liaison for cost effective access to systems architecture development facilities that provide concurrent design and simulation capabilities.

532 **Earth Science Missions Branch**

The Earth Science Missions Branch enables scientific discovery by providing end-to-end systems engineering for the NASA Earth Science Enterprise and cross Enterprise activities. These activities span the entire life cycle from advanced concepts through implementation. The scope of these systems engineering activities cover all flight and ground system elements, including end-to-end data flow from the science instrument to the end user. The Earth Science Missions Branch also develops implementation and risk mitigation strategies for the infusion of new technologies into these Earth Science Enterprise efforts, ensuring

that technology advancements are carried from concept through final design.

533 **Space Science Missions Branch**

The Space Science Missions Branch enables scientific discovery by providing end-to-end systems engineering for the NASA Space Science Enterprise and cross Enterprise activities. These activities span the entire life cycle from advanced concepts through implementation and flight operations phases. The scope of these systems engineering activities cover all flight and ground system elements, including end-to-end data flow from the science instrument to the end user. The Space Science Missions Branch also develops implementation and risk mitigation strategies for the infusion of new technologies into these Space Science Enterprise efforts, ensuring that technology advancements are carried from concept through final design.

540 MECHANICAL SYSTEMS CENTER

The Mechanical Systems Center (MSC) is an innovative center of expertise which provides multidisciplinary capabilities and technology development to design, analyze, fabricate, integrate, test, and launch advanced scientific instruments and support platforms for a variety of ground-based, sub-orbital, and orbital space and earth science missions.

Performs the material selection and qualification, mechanical design, structural analysis, development, assembly, mechanical integration, and testing of spacecraft, subsystems, instruments, payload support structures, deployable mechanical and electromechanical subsystems, and ground support equipment. Develops electromechanical devices for ultra-high precision, low disturbance, cryogenic, long life, and other unique applications. Performs the thermal design, analysis, development, integration, and test of spacecraft, instrument, and payload thermal control subsystems. Responsible for contamination analysis, testing, evaluation, monitoring, and protection of critical subsystems, components, and facilities. Performs multidisciplinary systems trade studies directed toward optimizing the mechanical and thermal performance, as well as resource requirements, of state-of-the-art spacecraft, instruments, and payloads. Provides simulations and assessments of structural integrity, functional performance, and safety during all phases of the mission. Provides support for transportation of the payload to and within the launch site, field operations, and pre- and post-launch activities.

Operates, maintains, and provides engineering support for a comprehensive array of facilities for manufacturing, assembly and integration, environmental simulation, and testing and evaluation. Provides broad technical capabilities in the material sciences, materials assurance technology, and applications directed toward assuring the overall safety and reliability of flight and ground systems.

Provides leadership and vision to plan, implement, and manage an active research and technology program through ground-based and flight experiments to advance the state-of-the-art in areas such as materials performance and technology; advanced heat transport and thermal control devices; ultra-high precision and long-life mechanisms; contamination science; and precision deployable, lightweight, and low-cost structures. Performs advanced research in support of the development of improved design and analytical tools and environmental testing capabilities. Maintains an active outreach program for developing partnerships with other NASA centers, government agencies, industry, and universities.

Coordinates the branches within the MSC and works in close cooperation with

other GSFC organizations and integrated product teams to develop products and provide expertise. Provides technical oversight, evaluation, consultation, and support to GSFC, NASA, government agencies, industry, and universities for flight project teams, instrument developers, design review teams, anomaly review boards, failure analysis teams, Technical Evaluation Panels, and Source Evaluation Boards.

541 MATERIALS ENGINEERING BRANCH

Provides the GSFC with a broad technical support capability in the materials sciences, technology, and applications, to support the design and assure the overall reliability of flight projects, experiments, and ground support operations, and, as required, for other NASA facilities and government agencies. Acts as the GSFC's focal point for consultation, control, and review of all materials, lubricants, materials systems, and designs intended for Goddard flight missions; serves as the central contact for the investigation of all spacecraft materials problems and failures and their resolution; and assists management in arriving at materials policy goals and guidelines of direct benefit in the design, development, and qualification of flight hardware. Provides a wide spectrum of materials expertise in support of GSFC's flight projects, development teams, design, review teams, and NASAwide committees. Maintains a central office directly interfacing with flight projects and experimenters in matters relating to the review of designs and the selection of materials, processes, and lubricants from the conceptual stage to final application. Plans, implements, and manages research and development programs design to advance materials performance and materials technology, and to develop technical data not available (or at best questionable) for direct application to flight programs. Reviews selected procurement documents to ensure inclusion of materials and lubricants requirements by appropriate contracting officers as provided for in the Procurement Request Handbook (GHB 5150.1) and Contract Drafting Handbook. Provides a repository for materials information and its dissemination via technical memoranda, reports, and papers suitable for publication to the scientific and engineering community.

542 MECHANICAL SYSTEMS ANALYSIS AND SIMULATION BRANCH

Provides mechanical and multidisciplinary systems modeling, analyses, and simulations for the development of state-of-the-art space flight systems in order to optimize the design and ensure that these systems meet their performance requirements. Provides senior system analysts and analytical discipline support to GSFC-managed programs. Conducts supporting system analysis, simulation, trade-off, and evaluation studies to aid in the development, monitoring, and verification of systems. Operates, schedules, and manages general-purpose computer facilities to support required analyses and simulation. Conducts

research, development, and maintenance of advanced computational capabilities for accurate and efficient systems analysis and simulation of present and planned flight systems.

Leads the mechanical, thermomechanical, and optomechanical aspects of multidisciplinary systems analyses including Structural Thermal Optical Performance (STOP) and jitter analyses. Supports, through analyses, the development and maintenance of system error budgets. Conducts necessary mechanical discipline and multidiscipline analyses to ensure that the system design is feasible, optimal, and verified for mechanical systems for Phase A, Phase B, and Phases C/D, respectively, and that all mechanical subsystems and components are compatible and will perform within specification. Provides graphical simulations of mechanical systems for a variety of studies including robotic motion studies, field of view interaction, mechanism operation, subassembly integration, vision system verification, as well as supporting system simulation video animations. Coordinates the generation of models, the methods of analysis, the techniques for model verification and validation, and administration of the computer systems needed to perform the work. Responsible for the definition and maintenance of the standard GSFC NASTRAN program.

Conducts structural analysis utilizing NASTRAN or other advanced programs in support of the design and qualification of flight structures. This includes finite-element math modeling, model correlation to test data, and coupled spacecraft/ launch vehicle transient dynamic analysis to determine the payload structural dynamic response to the launch vehicle induced environment. Performs analytical predictions of the resulting flight loads, structural stresses, fracture/ fatigue life, vibroacoustic environments, and margins of safety. Performs fracture control analysis, recommends nondestructive examinations, and provides safety documentation. Analytically determines test article response to test facility induced loads and determines realistic vibration levels and notching criteria for existing general vibration specifications to aid in reducing test risk and costs. Develops test plans, monitors test programs, reviews test results in design adequacy, and ensures that all structurally relevant safety requirements are satisfied. Performs advanced research in support of the development of improved analytical capabilities, such as spacecraft low-frequency transient and vibroacoustic environments, and the design optimization of advanced composite materials.

543 MECHANICAL ENGINEERING BRANCH

Performs structural and mechanical design and/or provides technical oversight for selected in-house and out-of-house Space Transportation System (STS) and Expendable Launch Vehicle (ELV) launched spacecraft and instrument structures,

deployment systems, and associated mechanical ground support equipment. Provides supervision and/or support for fabrication, assembly, integration and test, transportation of payloads, and launch site operations. Initiates, develops, and provides plans and procedures for mechanical assembly and qualification testing of spacecraft and instruments. Provides coordination of all mechanical system interfaces between spacecraft and launch vehicle. Performs structural analyses in support of flight hardware design. Provides advanced development and hardware implementation for maintaining state-of-the-art Computer-Aided Design (CAD) technology.

Performs conceptual studies for proposed spacecraft and instruments in support of flight projects and advanced study programs. Generates mechanical systems input, including structural and packaging designs, development and verification plans, mass properties, critical clearances, fields of view, and cost estimates. Provides advanced, state-of-the-art, three-dimensional CAD technology to support these conceptual studies as well as detailed mechanical design and drafting efforts. Conducts advanced research and studies in support of new structural design concepts, precision large deployment systems, fabrication and assembly techniques, and aerospace materials, such as advanced composites.

Provides senior-level technical oversight, evaluation, consultation, and review for out-of-house projects, contract proposals, and design review teams. Areas of expertise include structural and mechanism design, structural design analysis, fabrication and assembly, alignment, integration and test, transportation of payloads, and launch site support. Ensures coordination of all mechanical system interfaces among instruments, subsystems, spacecraft, and the launch vehicle. Evaluates spacecraft assembly, alignment, and qualification testing plans to ensure compliance will all safety and performance requirements. Monitors the performance of all system and subsystem level development, qualification, acceptance, and performance testing to ensure compliance with all requirements.

Performs and/or directs the conceptual and detail design, development, integration, and test of major structural and mechanical systems for in-house projects. Performs structural design analyses and supports fabrication and assembly for mission-unique subsystems such as instruments, payload adapters, and solar array, antenna, and experiment release and deployment systems, as well as any necessary mechanical ground support equipment, such as transportation and turnover dollies, lifting slings, and gravity negation systems. Initiates, develops, and provides plans and procedures for mechanical integration and qualification testing of spacecraft systems and instruments. Provides coordination of all mechanical system interfaces between the spacecraft and launch vehicle, performs safety verification, and provides appropriate documentation.

544 ELECTROMECHANICAL SYSTEMS BRANCH

Provides discipline support in the area of electromechanical systems engineering. Conceives, analyzes, designs, develops, directs, tests, and provides the required mechanical, optomechanical, magnetic, controls, electrical, and electronics expertise to support the development of in-house electromechanical devices and systems for flight instruments and spacecraft subsystems. Responsible for the design, analysis, fabrication, test, and integration of precision electromechanical systems for scanning, pointing, and tracking applications including the development of state-of-the-art electronic systems to control the mechanisms. Develops flight structures such as instrument structures, optical benches, telescopes, collimators, and antenna booms. Verifies the performance of electromechanical components and systems through all the stages of development from conceptual design to on-orbit testing. Conceives and conducts advanced and supporting research to develop technology applicable to existing and future space flight electromechanical systems such as deployable appendages, gimbals, cryogenic mechanisms, smart structures, and magnetic bearings. Supports project teams, experimenters, instrument managers, technical review teams, failure analysis teams, Technical Advisory Committees, and Source Evaluation Boards. Provides electromechanical system engineers to on-going flight projects. In cooperation with experimenters and study teams, conducts conceptual and feasibility studies for new instruments that include system level performance, cost, and schedule trade-offs. Provides technical oversight, evaluation, consultation, and review of out-of-house projects and contract proposals.

Develops mechanisms and structures for precision flight instruments and spacecraft subsystems. Designs, analyzes, fabricates, assembles, and tests flight assemblies such as deployable booms and solar array drive systems, choppers, shutters, scanning, and focusing mechanisms. Determines the adequacy of the design, mass properties, and margins of safety of mechanisms, instrument structures, and mechanical components to withstand the launch loads and operate for the specified period of time under environmental conditions that are experiences in orbit. These include bearings design and lubricant selection. Plans and conducts environmental tests, including life testing of electromechanical systems to verify the adequacy and accuracy of the design. Conceives and conducts research to develop and apply the state-of-the-art in mechanisms and instrument structure design including new components, materials, and processes and the use of computer-aided tools for the design, analysis, and optimization of mechanisms, structures, and electromechanical components and systems. Plans and provides specifications and procedures for the fabrication, assembly, alignment, integration, and test of instrument structures and mechanism systems. Provides ground support equipment such as turnover dollies and environmentally-controlled shipping containers. Maintains technical expertise and provides

discipline support in the areas of structural design analysis, structural dynamics, and optomechanical design.

Develops devices and systems for the drive, sensing, and control of precision flight instruments and spacecraft subsystems. Designs, analyzes, integrates, and tests electronic systems that control mechanisms driven by electromechanical actuators and provides that required interfaces to the spacecraft power and command and data handling systems. Designs, analyzes, and tests devices used in sensing or actuating electromechanical systems such as tachometers, transformers, electromagnets, and electric motors. Plans, coordinates, and provides specifications and procedures for the design, fabrication, assembly, and packaging of the electronic circuit boards. Designs and conducts analyses and tests to determine the parameters that characterize the dynamic behavior of the control system and of the various components that comprise the system. Develops mathematical models of the control systems that integrate the dynamic models of the mechanisms, electronics, and instrument structure. Performs analysis and simulation studies of control systems to predict the system performance and assess the sensitivity to parameter variations, system level interactions, and the effect of disturbances. Designs the control system including the control algorithms, determines the choice of sensors and actuators, and develops the control software. Plans and coordinates the tests for performance verification and environmental qualification of sensors, actuators, and mechanism control electronics. Provides ground support equipment to simulate electrical interfaces and verify the performance of the system. Maintains technical expertise and provides discipline support in the areas of analysis, design, and test of control systems, precision and low noise electronics, analog and digital signal processing, logic design and microprocessor systems, power electronics, sensors, and actuators. Conceives and conducts research to develop and apply the state-of-the-art in electronic components and systems, actuators, and sensor technology.

545 THERMAL ENGINEERING BRANCH

Responsible for thermal engineering for all GSFC-managed spacecraft, instruments, experiments, and sensors. Included are free flyers, STS payloads, and STS equipment designed to deploy, retrieve, and maintain free-flying spacecraft. Conceives, develops, and reviews the thermal design and associated elements for all of the above. Responsible for contamination engineering of GSFC spacecraft, experiments, and sensors for STS payloads and free-flyer missions. Provides support for tests, launch, and mission operations. Initiates and develops new hardware and software to meet advanced spacecraft and sensor requirements.

Responsible for the development of advanced thermal hardware and thermal

technology for future spacecraft, instrument, and sensor applications including heat pipes, two-phase heat transfer systems, advanced coatings, and heat pumps. Develops and modifies thermal control coatings - such as paints, films, and composites - and application techniques to meet the specific requirements of components, instruments, and spacecraft. Responsible for engineering design, development, and operation and flight experiments to verify thermal hardware and coatings adequacy and to investigate contamination and space environment degradation mechanisms. Develops, operates, and maintains unique facilities for testing specialized thermal and contamination control devices and components, and test facilities for space environment degradation simulation to perform flight qualification and characterization tests of thermal control coatings. Perform tests to measure the thermal/optical properties of thermal control coatings.

Conceives and develops the contamination control design and associate elements for GSFC spacecraft, experiments, and sensors for STS payloads and free-flyer missions. Performs contamination analyses to predict the migration of contaminants to critical surfaces during ground and on-orbit conditions. Conceives and develops flight experiments and performs laboratory measurements to provide basic contamination data. Provides support for tests and launch and mission operations. Initiates and develops new hardware and software to meet advanced spacecraft and sensor requirements.
Develops and maintains advanced thermal design/thermal analysis, including graphics capability for thermal engineering and contamination engineering.

Develops and maintains databases of thermal and contamination property and test data. Develops and maintains expertise in discrete thermal technologies such as radiative cooler design and thermal analysis, cryogenic temperature thermal design and analysis, and continuum aerodynamic heating.

546 CARRIER SYSTEMS BRANCH

Provides mechanical discipline engineering required for the design, implementation, and maintenance of payload carrier systems. The primary focus is on STS payloads such as Spartan and Hitchhiker carriers, small ELV payloads, and suborbital payloads including sounding rockets, balloons, and aircraft. These carriers are utilized primarily for low cost, relatively high risk, quick reaction missions. Provides expertise in handling, staging, and assembly operations and logistics for solid-fuel rocket motors, rocket launchers, rocket-handling equipment, and related hardware. Responsible for forming and leading mechanical teams to support these projects, which will draw members and expertise from across the MSC.

Responsible for the entire life cycle of the payload carrier mechanical systems. This includes design, verification/validation, integration, flight operations, post-flight recovery, and maintenance/recertification of multi-mission systems. Evaluates payload mechanical systems for compliance with carrier systems and launch vehicle requirements and advises projects in this regard. Serves as the technical authority for these projects on mechanical issues. Provides mechanical engineering services to payload developers for selected in-house projects.

To fulfill these responsibilities, the branch maintains a wide range of technical skills including two-dimensional and three-dimensional CAD-based mechanical design capability; classical, finite element, and kinematic analysis capabilities to support design; expertise in the mechanical integration and field support of missions; and a working knowledge of a variety of related disciplines such as vacuum technology, fracture control, and electromechanics.

547 ADVANCED MANUFACTURING BRANCH

The Advanced Manufacturing Branch provides manufacturing and fabrication support for developing state-of-the art science instruments, spacecraft systems, components, and devices. The Branch provides quick reaction design, development, fabrication, assembly, integration, and modification of science experiments and instruments for ground-based aircraft, balloon, space flight, and laboratory research. To accomplish these activities, the Branch:

- Develops new and innovative machining techniques to fabricate and assemble advanced instruments, mechanisms, and sensor designs for both conventional and microstructures. Examples include: Micro-Electromechanical Systems (MEMS) Packaging and micro-optical structures that support Nanosat missions.
- Provides expert assembly and machining support to GSFC research communities. This support includes instrument development, detectors, laser optics, optics, precision deployables, cryogenics, and mechanisms, among others.
- Advances the use of state-of-the-art techniques for Computer-Aided Manufacturing (CAM) systems and provides automated manufacturing capability. Advises scientists, engineers, and experimenters on the practical design application of current and advanced CAM technology. Provides the links between mechanical design and rapid prototyping equipment.
- Provides conceptual and detailed mechanical design support for the development of flight systems and ground support equipment. Develops designs in both 2-D and 3-D CAD formats, which have concurrent engineering links to CAM and CAE applications.
- Performs and directs studies, develops component hardware, and provides a

base of expertise in advanced composite materials processing techniques.

- ❖ Provides practical consulting and new process development services in the fields of electroplating, chemical processing, mechanical product finishing, adhesive bonding, and composite H/W development for state-of-the-art instrument and spacecraft components as well as micro-electromechanical and optical structures.
- ❖ Supports advanced hardware development by evaluating, investigating, and resolving manufacturing difficulties resulting from process, design, and/or material deficiencies.
- ❖ Provides design review services regarding the producibility and practicality for fabrication of advanced instrument and sensor designs and spacecraft components.
- ❖ Also provides metrology consulting services to GSFC, NASA, contractors, and other government agencies.
- ❖ Teams with scientists and engineers to conceive piece part designs that will need scientific performance goals.

549 ENVIRONMENTAL TEST ENGINEERING AND INTEGRATION BRANCH

Responsible for engineering, management, planning, development, and implementation of environmental tests and test programs for spacecraft, instruments, and subsystems per requirements specified in project verification plans or established by the project customer. Responsible for acquisition, management, upgrade, and operation of the integration and environmental test capabilities located in buildings 7, 10, 15, 29, and the 300 area, including particulate-controlled payload integration areas and test facilities for vibration, acoustics, shock, acceleration, modal survey, static load, thermal vacuum, solar vacuum, temperature and humidity, radio frequency interference, magnetic fields, and associated measurements such as mass properties.

Responsible for advancing and improving environmental test techniques, facilities, processes, and approaches. Develops requirements and manages studies and analyses to advance test methods and techniques. Provides integration and environmental test expertise and consulting to GSFC and other project customers for assisting in planning, managing, assessing, procuring, and troubleshooting integration and test activities. Maintains and provides project-level environmental verification expertise to assist project customers and systems engineering to ensure that system performance requirements are met.

Provides engineering and technician expertise, facilities, instrumentation, and technical support for the structural and mechanical integration, test, handling, and launch of spacecraft structures, mechanisms, experiments, and spacecraft. Provides the technical interface to customers for planning, coordinating, and

executing mechanical integration activities. Manages the operation and use of clean rooms and assigns laboratory space for the integration function. Provides management information and coordination for the shared use of buildings 7, 10, 15, and 29. Provides integration area particulate and molecular contamination control expertise and support to project customers and for top-level oversight of clean room operations. Provides Facility Operations Managers for buildings 7, 10, 15, 29, and the 300 area.

549.1 Environmental Project Engineering Section

Manages the advanced planning, engineering, and implementation coordination of environmental test programs for both internal and external project customers. Provides resource requirements definition and oversight by creating project estimates and proposals, negotiating resource requirements for both manpower and funding, tracking project costs, jointly authorizing project task statements of work with the project customer, managing contractual vehicles for work execution, and managing external customer documentation requirements including funding documents and agreements. Provides implementation coordination by coordinating activity schedules between project customers and test operations, providing the primary customer interface and leadership of the customer support team, ensuring that all integration and test requirement information needed for safe execution are collected and disseminated, and coordinating the customer support team to ensure that all customer requirements are achieved.

Provides technical consultation to hardware engineers, project staff, verification authorities, and contractors regarding state-of-the-art test methods and alternatives for test, retest, test waivers, and associate decision-making. Advises project customers of approaches to verify satisfactory performance in environments encountered during all mission phases. Assists project customers in the development of project-unique performance verification plans and specifications by interpreting and applying general policy to unique project designs and constraints. Assists project customers in tracking the environmental test program activities to collect, summarize, and evaluate results. Provides an environmental verification engineering analysis review capability by providing and coordinating activities of test engineering disciplines, project customer engineering, and systems engineering.

549.2 Structural Dynamics Test Engineering Section

Responsible for the engineering design, implementation, and conduct of payload-unique environmental tests simulating launch, reentry, and landing loads, including vibration, shock, acoustics, acceleration, and static loads. Determines

the mass properties and modal characteristics of payloads and provides engineering for the conduct of functional demonstrations such as dynamic testing of payload deployment devices. Provides the technical interface to customers for planning, coordinating, and executing test activities. Provides test planning, approaches, procedures, support equipment, facilities, facility modifications, execution and reporting. Develops requirements and manages studies to advance and improve test methods and techniques. Provides technical consultation to hardware engineers, project staff, and contractors regarding state-of-the-art test methods, alternatives, problem resolution, and associate decision making.

Responsible for facility technical requirements, operations, maintenance, upgrade, and associated services. Responsible for review and evaluation of contractors who perform these functions.

549.3 Electromagnetic Test Engineering Section

Responsible for the engineering, design, and implementation and conduct of payload unique environmental tests, compensations, exposures, and measurements including magnetic fields, electromagnetic compatibility, electromagnetic interference, and electrostatic discharge. Provides the technical interface to test customers for planning, coordinating, and executing test activities. Provides test planning, approaches, procedures, support equipment, facilities, facility modifications, execution, and reporting. Develops requirements and manages studies to advance and improve test methods and techniques. Provides technical consultation to hardware engineers, project staff, and contractors regarding state-of-the-art test methods, alternatives, problem resolution, and associated decision-making.

Responsible for facility technical requirements, operations, maintenance, upgrade, and associated service. Responsible for review and evaluation of contractors who perform these functions.

549.4 Space Simulation Test Engineering Section

Responsible for the engineering design, implementation, and conduct of payload unique environmental tests simulating payload pre-launch, launch, orbit, and landing thermal conditions including thermal vacuum, solar vacuum, and temperature and humidity conditioning to test payload functional performance capabilities. Provides the technical interface to test customers for planning, coordinating, and executing test activities. Provides test planning, approaches, procedures, support equipment, facilities, facility modifications, execution, and reporting. Develops requirements and manages studies to advance and improve test methods and techniques. Provides technical consultation to hardware

engineers, project staff, and contractors regarding state-of-the-art test methods, alternatives, problem resolution, and associated decision-making.

Responsible for facility technical requirements, operations, maintenance, upgrade, and associated services. Responsible for review and evaluation of contractors who perform these functions.

550 INSTRUMENT SYSTEMS AND TECHNOLOGY CENTER

The Instrument Systems and Technology Center (ISTC) provides technical leadership for the full life cycle of instrument development. It is a Center of instrument engineering expertise that provides development of innovative new measurement concepts and techniques, development of advanced instrument concepts, scientific instrument proposal support, instrument system definition, analysis, and implementation as well as advanced technologies and discipline support to enable advanced state-of-the-art Earth and Space science missions. The ISTC collaborates closely with the science community and other customers to identify new and emerging instrument technology requirements. The Center provides leadership and vision in developing and implementing technology programs aimed at satisfying needs and enabling future science missions, reducing mission cost, enhancing instrument performance, and/or simplifying instrument design and development.

The ISTC is an innovative center that provides engineering leadership and support to instrument concept study teams, proposal teams, and development teams to support the end-to-end conceptualization and development of advanced state-of-the-art Earth and Space science missions. It provides engineering discipline expertise, vision, and leadership in the areas of detector systems, optics, cryogenics and fluids, lasers and electro-optics and microwave instrument technologies.

The ISTC provides radiation detection instrument system technologies including design, development, assembly, testing, calibration, and support for measuring all regions of the electromagnetic spectrum. Detector and instrument front-end development encompasses focal plane technology, new materials, electronic readout, and the development and application of semiconductor processing techniques in order to provide a seamless interface to our customers. The Center provides optical design and analysis, component development, and instrument assembly, alignment, and testing support. The ISTC maintains and advances GSFC capabilities in cryogenic aerospace system design and development as well as other associated unique cryogenic and fluid system technologies. Laser and electro-optical capabilities are focused on advanced laser and lidar sensors and components for earth science and space exploration. In the microwave area the emphasis is placed on the development of new instrument unique technology capabilities that will support science goals and require innovation and present significant challenges to the development of successful instrument systems.

The ISTC provides and operates a comprehensive array of laboratory and computer facilities to support key instrument technology developments and the

design, development, manufacture, assembly, integration, calibration, and testing of a broad range of instrument systems and subsystems.

The ISTC interfaces closely with the Space Earth Sciences Directorates to support proposal development and conceptual designs, plan and implement technology developments, and commercialize newly developed technologies. It performs its work in close cooperation and partnership with other AETD centers, GSFC Directorates, NASA Centers, government agencies, international agencies, industry, and academia. It sustains a program of outreach to minority and educational communities.

551 OPTICS BRANCH

The Optics Branch provides optical engineering and technology expertise to instrument development teams, study teams, and proposal teams to enable the end-to-end conceptualization and development of optical systems for Earth and Space science instruments, specifically:

1. Collaborates with other AETD organizations, the Earth and Space Science Directorates, the AETD, and external customers to provide appropriate technology-enabling activities that are responsive to Goddard's strategic initiatives.

2. Provides and maintains facilities, laboratories, analytic tools, and technical expertise to include; optical system design and analysis, optical component development and test, optical materials and thin films, optical system assembly/ alignment/test, and opto-mechanical design and analysis.

3. Provides technology leadership and vision by conceiving, planning, implementing, and conducting in-house or external technology programs that enhance the Branch's core capability and expertise in those areas of advanced optical technologies needed for future Space and Earth science instruments. External technology programs are enabled by partnering with industry, the university community, other government laboratories and NASA Centers. The Optics Branch proactively works to transfer technology to the private sector, as well as foster broad community outreach.

552 CRYOGENIC AND FLUIDS BRANCH

The Cryogenics and Fluids Branch cryogenic and fluid system expertise to instrument development teams, study teams, and proposal teams to enable the end-to-end conceptualization and development of Earth and Space Science instruments. The Branch conceives, designs, analyzes, develops, tests, and

evaluates new state-of-the-art aerospace cryogenic cooling and instrument fluid systems. Designs, analyses, develops, tests, and evaluates specialized instrument fluid systems, and leads the NASA effort to develop long life cryogenic coolers. Provides technical leadership in high performance liquid helium systems; sub-Kelvin coolers; hybrid cooling systems consisting of two or more cooling systems such as radiative/mechanical cooler/sub-Kelvin cooler combinations; and using new Superconducting Quantum Interference Device (SQUID) subsystems, specifically;

1. Collaborates with other AETD organizations, the Earth and Space Sciences Directorates, and external customers to provide appropriate technology-enabling activities that are responsive to Goddard's strategic initiatives.

2. Provides leadership and vision in conducting a broad range of advanced cryogenic and instrument related fluid system development activities by conceiving, planning, implementing, and conducting in-house or external technology programs in order to meet current and future Space and Earth science mission needs. External technology programs are enabled by partnering with industry, the university community, other government laboratories, and NASA Centers. The Cryogenic and Fluid Systems Branch proactively works to transfer technology to the private sector, as well as foster broad community outreach.

3. Provides and maintains ground test facilities required for the development and evaluation of cryogenic systems and components, including unique cryogenic cooler test beds with advanced measurement capabilities to support technology developments.

4. Supports the design, development, testing, and flight of cryogenic systems. This effort encompasses teaming with scientists and technologists in all stages of development, from pre-phase A research in next-generation instruments, through to supporting flight programs.

553 DETECTOR SYSTEMS BRANCH

The Detector Systems Branch provides radiation detector and front-end electronics technology expertise to instrument development teams, study teams, and proposal development teams to enable the end-to-end conceptualization and development of scientific instruments for Earth and Space Science research, specifically:

1. Collaborates with other AETD organizations, the Earth and Space Science Directorates, and external customers to provide appropriate technology enabling activities that are responsive to Goddard's strategic initiatives.

2. Provides leadership and vision in conducting a broad range of advanced instrument technology activities by conceiving, planning, implementing, and conducting in-house or external technology programs in order to meet current and future Space and Earth mission needs. External technology programs are enabled by partnering with industry, the university community, other government laboratories, and NASA Centers. The Detector Systems Branch proactively works to transfer technology to the private sector, as well as foster broad community outreach.

3. Provides and maintains facilities, laboratories, analytic tools, and expertise in the areas of advanced detectors, detector-specific electronics, and custom semiconductor devices.

4. Supports the design, development, testing, and flight of radiation detectors for all regions of the electromagnetic spectrum. This effort encompasses teaming with scientists and technologists in all stages of development, from pre-phase A research in next-generation instruments, through to supporting flight programs.

554 LASER AND ELECTRO-OPTICS BRANCH

The Laser/Electro-Optics Branch provides laser and electro-optical engineering and technology expertise to instrument development teams, study teams, and proposal teams to enable the end-to-end conceptualization and development of laser and electro optical systems for earth and Space Science instruments, specifically:

1. Collaborates with other AETD organizations, the Earth and Space Sciences Directorates, and external customers to provide appropriate technology enabling activities that are responsive to Goddard's strategic initiatives.

2. Provides leadership and vision in conducting a broad range of advanced instrument technology activities by conceiving, planning, implementing, and conducting in-house or external technology programs in order to meet current and future Space and Earth mission needs. External technology programs are enabled by partnering with industry, the university community, other government laboratories and NASA Centers. The Laser and Electro-Optics Branch proactively works to transfer technology to the private sector, as well as foster broad community outreach.

3. Provides and maintains facilities, laboratories, analytic tools, and expertise in the following technical areas; lidar systems, lidar detector technology, solid state laser transmitters, tunable lasers, image stabilization and pointing, and non-linear

optics technologies.

4. Supports the design, development, testing, and flight of laser and electro-optical systems. This effort encompasses teaming with scientists and technologists in all stages of development, from pre-phase A research in next-generation instruments, to supporting flight programs.

555 MICROWAVE INSTRUMENT TECHNOLOGY BRANCH

The Microwave Instruments Technology Branch provides engineering and technology expertise to instrument development teams, study teams, and proposal teams to enable the end-to-end conceptualization and development of microwave instrument systems for Earth and Space Science missions. Emphasis is placed on the development of new capabilities that require innovation and present significant technology challenge in order to permit successful scientific instrument systems. The Branch provides the Center lead in microwave instrument technology development and serves as the primary AETD interface to the science community for microwave instruments. The Branch advocates and performs cutting-edge technology development to enable new measurements, improved performance, and reduced cost, size, and mass of active and passive sensors over a broad range of Earth and Space science applications. It develops new concepts, analyzes system performance, develops new technology, integrates and tests instrument/detector systems, and supports experimental field campaigns, airborne and space missions, specifically:

1. Collaborates with other AETD organizations, the Earth and Space Sciences Directorates, and external customers to provide appropriate technology enabling activities that are responsive to Goddard's strategic initiatives.

2. Provides leadership and vision in conducting a broad range of advanced instrument technology activities by conceiving, planning, implementing, and conducting in-house or external technology programs in order to meet current and future Space and Earth mission needs. External technology programs are enabled by partnering with industry, the university community, other government laboratories and NASA Centers. The Microwave Instrument Technology Branch proactively works to transfer technology to the private sector, as well as foster broad community outreach.

3. Provides and maintains facilities, laboratories, analytic tools, required to support advanced microwave instrument technology developments.

4. Supports the design, development, testing, and flight of microwave instrument systems. This effort encompasses teaming with scientists and technologists in all

stages of development, from pre-phase A research in next-generation instruments, to supporting flight programs.

556 INSTRUMENT SYSTEMS BRANCH

The Instrument Systems Branch provides technical leadership for the full life cycle of instrument development. This includes development of innovative new measurement concepts and techniques, development of advanced instrument concepts, support of scientific instrument proposals, instrument system definition, analysis, and implementation, specifically:

1. Collaborates with other AETD organizations, the Earth and Space Sciences directorates, and external customers to provide appropriate instrument-enabling activities that are responsive to Goddard's strategic initiatives.

2. Provides leadership and vision in conducting a broad range of advanced instrument management and instrument systems engineering activities by conceiving, planning, implementing, and conducting in-house or external technology programs in order to meet current and future Space and Earth mission needs. External programs are enabled by partnering with industry, the university community, other government laboratories and NASA Centers. The Instrument Systems Branch proactively works to transfer technology to the private sector, as well as foster broad community outreach.

3. Provides and maintains facilities, laboratories, analytic tools, required to support instrument systems development.

4. Supports the design, development, testing, and flight of microwave instrument systems. This effort encompasses teaming with scientists and technologists in all stages of development, from pre-phase A research in next-generation instruments, to supporting flight programs.

560 ELECTRICAL SYSTEM CENTER

The ESC provides leadership and vision in identifying, sponsoring, advancing, developing, improving, and validating flight electrical/information systems and technologies. These cross cutting technologies are specifically aimed at enabling future science missions, reducing mission cost, enhancing data processing and product dissemination, and simplifying mission design, development and operation. The ESC achieves this through the close collaboration and leveraging of resources with other NASA Centers, other Government agencies, academia, and industry. Systems and technologies are verified through ground testing in flight testbeds, technology demonstration flights, and science mission insertion. In addition, the ESC ensures commercialization to industry partners through an active technology transfer program.

The ESC is an innovative Center of expertise in the implementation of flight and ground electrical/electronics systems in support of NASA programs and projects, with specific activities in the GSFC Earth Science, Space Science and Technology focus areas. The ESC collaborates with the science community and other customers to meet their electrical/electronics and technology needs through the design, implementation, and integration of electrical systems and system components. The ESC works in close partnership with the other AETD Centers, especially the Information Systems Center and the Guidance, Navigation, and Control Center, to achieve many of its objectives, with the ESC leading in the areas of flight hardware (and the required EGSE Integration and Test equipment), flight systems architectures, and flight technologies.

The ESC provides technology, capability, and products in electrical/electronic systems design, development, implementation, and test. It provides expertise in the areas of electrical systems/architecture design, development, implementation, and test; design of digital and analog systems for spacecraft and instrument systems; Integration and Test (I&T) of satellite, rocket, aircraft, shuttle, and balloon-borne scientific instruments, payloads, and spacecraft; flight electric design, including flight harnesses, health and monitoring systems, and pyrotechnic/mechanism deployment electronics; RF, microwave and millimeter wave instruments, communication systems, and associate components; flight components (processors, memory, I/O, fiber optics, power conversion and storage devices, communications elements, ADCs, data compression, etc.,); design capability for custom ASICs and system design/fabrication leading to flight, radiation effects, radiation orbit environment predictions, radiation testing (SEU, SEL, TID), and system analysis; power generation, energy storage, and high and low voltage power management and distribution systems for instruments and spacecraft and advanced photovoltaic, electrochemical, electronic, and other technologies for space power applications; new technology packaging techniques

such as Chip On Board, Wafer Stacking, Multifunctional Structures; and EGSE systems for flight and I&T. The ESC operates and maintains laboratories unique to its functions.

The ESC represents NASA as a leader in electrical systems and architectures for flight spacecraft, instrument electronics and their associated ground support equipment. It provides expertise in disciplines required to implement flight electrical systems to GSFC product teams and external users. It leads internal and external subteams to implement and deliver electrical/information system products, services, and/or capability to GSFC projects to meet mission needs. For flight projects, the ESC supports end-to-end simulations and tests to verify readiness to support flight missions. It participates in the planning of future missions and in the development of standards to guide evolution of future flight and ground electrical systems. The ESC also sustained a strong program of outreach to minority and educational programs.

561 FLIGHT ELECTRONICS BRANCH

The Flight Electronics Branch is responsible for providing the Center with the technical expertise in the development of Flight Data Systems and its related components for space flight applications, in the discipline area of Command and Data Handling systems engineering, and in the discipline of space radiation. This engineering support is provided to Earth/Space Science, other AETD organizations, and Flight Programs & Projects Project Directorates for both in-house and out-of-house efforts with regards to the analysis, design, fabrication, procurement, test, integration, and operation of Flight Data Systems and related components, and the validation of instrument and spacecraft components for the space radiation environment. The Branch spearheads the development of advanced technologies in instrument/spacecraft data buses, radiation-harden microprocessors, mission unique electronics, instrument & spacecraft subsystem interface devices, and bulk storage components. The Branch supports the development of new instrument/spacecraft architectures with regards to partnering with industry and other agencies, proposal development, and phase A&B studies and supports the development of advanced GN&C and mechanism electronics.

562 COMPONENT TECHNOLOGIES AND RADIATION EFFECTS BRANCH

The Component Technologies and Radiation Effects Branch provides unique and essential parts, radiation, and advanced technology support to internal and external customers and partners to meet mission reliability, cost, and schedule goals. The support is provided in two areas:

- Flight Project Support

- Applied Research

Flight project support encompasses aspects of reliable systems development including:

- Space environment definition and simulation
- Part selection, evaluation, and testing
- Instrument development and calibration
- Characterization and validation of technologies
- Application engineering
- Anomaly investigation
- Maintain databases for parts and radiation information

The applied research aspects of the branch supports efforts in:

- Parts and technology issues
- Emerging and State-of-the-Art technology developments
- Development and extension of device and environment models
- Emerging radiation hardness assurance issues
- Instrument and payload development
- Novel materials and microelectronics developments
- Emerging photonics
- Evaluation and analysis of space flight data (including anomalies)
- Partnerships
- Technology transfer

To fulfill this mission, the branch has extensive laboratories and computer-based simulation and analysis capabilities, and an active presence in the aerospace community including conference participation, partnerships, and data dissemination.

563 POWER SYSTEMS BRANCH

The Power Systems Branch provides the Center with technical expertise in the field of electrical power for space applications. Power subsystem engineering is provided to support for all phases of scientific instrument, special payload, and spacecraft flight programs from conceptual design, through hardware development and test, to end-of-life operations. Electromechanical discipline engineering support is provided to advance energy storage technologies by developing longer life and higher energy density primary and secondary batteries, respectively, for special payloads and spacecraft applications. Photovoltaic discipline engineering support is provided to advance solar-electric energy

conversion technologies by developing higher efficiency solar cell arrays for space flight applications. Electronics discipline engineering is provided to advance power management, distribution, and conditioning technologies by developing efficient, low noise, high and low voltage power regulators and converters for scientific instruments, special payloads, and spacecraft.

564 MICROELECTRONICS AND SIGNAL PROCESSING BRANCH

The charter of the Microelectronics and Signal Processing Branch is to design, develop and infuse leading edge microelectronics devices and components for flight and ground customer applications, including the development and delivery of flight analog and digital systems that process science data and the development of the advanced technology associated with these systems. This includes but is not limited to front-end electronics, interface, analog signal filtering and conditioning, analog cryo temperature control systems, analog multiplexing and A/D conversion, digital signal processing and compression, C&DH and downlink interfaces. In addition, the Branch is responsible for analog and digital circuits that support various sensors and actuators. The Branch develops concepts and design, prototypes and tests these designs, builds engineering and flight models and performs subsystems testing and delivers these systems to the instrument or spacecraft developer. Pre-Phase A and Phase A studies and proposals are also supported by the Microelectronics and Signal Processing Branch, including support for the development of advanced electronics architectures.

The Branch will provide expert personnel and maintain tools capable of developing highly integrated ASIC and VLSI devices and modules for instrument, spacecraft and ground components. The efforts of the Branch will be focused on the needs of instruments, missions, and advanced technology development projects. The Branch will develop the requirements for, evaluate, and use state-of-the-art analog and digital design, test, simulation, and validation tools and equipment. In conjunction with industry, the Branch will sponsor and further the development and capability for the design and simulation of custom circuits.

Overall the Branch will maintain the following expertise in advanced and high speed analog and digital device design for both flight and ground applications, VLSI design experts in custom, semi-custom, and programmable devices, device packaging techniques such as multi-chip modules, chip-on-board, and state-of-the-art surface mount technology, circuit design methodologies (VHDL, Verilog) and advanced algorithmic development.

565 ELECTRICAL SYSTEMS BRANCH

Designs and develops orbital, sub-orbital and carrier electrical systems and

selected flight components such as harnesses, flight fiber optic networks, and special purpose interface hardware. Provides electrical systems leads to Instruments and for Project teams who develop electrical interfaces, performance requirements, functional test procedures, and electrical specifications for in-house space programs or provide unique electromagnetic compatibility requirements and generates the criteria and test approach needed to insure the electromagnetic compatibility of instrument and spacecraft hardware. Provides Electrical Leads to Principle Investigators to support unusual, quick-reaction missions or proposal development. Provides electrical Systems Managers and/or discipline support to out-of-house programs. Develops and provides sustaining engineering in support of the WFF Fixed and Mobile Real-Time Range Safety Data Processing, Range Control Center, Real-Time Mission Critical Data and Control Interface, Telemetry Data Processing, Tracking acquisition/designation, Meteorological, and Timing Systems to meet the requirements of the low earth-orbit, sub-orbital, and balloon flight projects.

566 GROUND SYSTEMS HARDWARE BRANCH

Responsible for design, development, acquisition, and integration of ground system hardware use for instrument and spacecraft integration and test (I&T) and space systems operations.

Includes system engineering to provide a set of ground system equipment to meet needs of spacecraft/instrument subsystem testing through full-end-to-end space system operations. Advocates development of advanced mission unique ground system equipment to meet future space ground communication and processing requirements such as (advanced error correction encoding, compression, modulation, high data rate and communication protocols). Integrates (custom or COTS/GOTS) hardware to simulate and exercise instrument/spacecraft/ground system electrical and data interfaces. Works closely with commercial vendors to integrate or modify COTS based systems to meet testing and operations needs. Commercializes developed technologies to encourage competitive low cost market for flight and ground system testing and operations equipment. Typically equipment provided by the GSHB will include off the shelf computing platforms (PC or workstations) augmented with unique hardware to support space systems testing and operations. Some examples of equipment provided or acquired by the GSH include: power system simulators, RF and communication systems, telemetry processing system (low and high rate), specialized EGSE including umbilical consoles, specialized data simulation devices to exercise GN&C processing and custom instrument interfaces to validate S/C processing software, command interface equipment mission and science data processing and storage equipment, spacecraft data and RF simulation equipment, user and operational network interface equipment, specialized raw data acquisition equipment (tape,

disk arrays, optical disk systems, etc.), specialized ground system store and forward equipment, multiprocessor/parallel/reconfigurable processing systems for high rate image processing requirements, troubleshooting, and interface test analysis equipment, and low cost/high rate ground station receive and transmit data acquisition and processing systems.

567 MICROWAVE SYSTEMS BRANCH

The Microwave Systems Branch is responsible for conception, analysis, design, development, and engineering state-of-the-art RF, microwave, millimeter wave and higher frequency component and systems for GSFC communications and instrument applications. It also provides communications and microwave instrument discipline support to other GSFC organizational elements and flight projects.

The Branch maintains core microwave engineering discipline support and facilities for the AETD, and supports the ISTC, Codes 400, 600, and 900 through the provision of microwave instrument engineering expertise and infrastructure and the development and implementation of flight microwave instruments. Branch members work closely with the ISTC in the development and evaluation of advanced microwave instruments.

The Branch, with appropriate spacecraft designers, develops spacecraft communication systems using current and advanced technology. Analytical studies and experimental investigations are proposed and conducted. It provides management, engineering, and supporting personnel for microwave communications discipline support to other GSFC organizational elements and to Flight Projects.

The Branch develops flight and ground communications equipment in support of the tracking and data acquisition requirements of GSFC low earth-orbit, sub-orbital, and balloon flight projects. This includes tracking, telemetry, and command systems that support launch operations and the collection of scientific data.

The Branch develops and tests state-of-the-art microwave instrument and communications antennas. Effort is concentrated on analytical design methods, but also includes materials properties, test and calibration methods, manufacturing techniques, and deployment procedures. Single and multiple beam reflectors and phased array antennas are developed to have effective sidelobe suppression, high beam efficiency, high polarization purity, and electronic or electromechanical beam scanning characteristics.

The Branch provides RF and microwave engineering expertise to the International Search and Rescue Satellite Aided Tracking (SARSAT) system for the development and improvement of applicable technology.

The Branch provides communications engineering discipline support in RF systems for the project management, system engineering, design, prototyping, hardware development, demonstration, test, documentation, procurement, and implementation of new and existing space communication systems in the N&MSC. This includes performing advanced systems studies, technology development and demonstrations in response to N&MSC needs, and providing consultation to the spaceflight customer community concerning Network systems and hardware capabilities. It supports the analysis, design, development, acquisition, and management of new space-to-ground and ground control communications systems, and maintains insight into the quality of the RF systems engineering services provided by contractors supporting the SN, GN, and other ground station projects.

Technology development are conducted in support of these major mission responsibilities with emphasis on antennas, low noise receivers, radiometers, and related instrument technologies, and transponders. Branch members conduct theoretical studies and develop simulations and models for communications systems, and support advanced technology development for instruments, including new microwave sensing systems for both Earth and space science disciplines. Emphasis is placed on activities associated with radiometers, radars, scatterometers, high-speed communication electronics, and advanced communications components for space-for-Earth and relay satellite applications.

568 FLIGHT SYSTEMS INTEGRATION AND TEST BRANCH

The System Integration & Test Branch is responsible for Integration and Test activities of Spacecraft, Instruments, Orbital Carrier Systems and Suborbital Carrier Systems, including complete functional and environmental testing and verification. System, subsystem, and payload/launch vehicle integration are included. As required by the Projects and/or Principle Investigators, the Branch supplies I&T Lead Engineers/Managers, Test Conductors and I&T Technicians to Teams, providing support from mission operations and post-mission deintegration. The Branch flight-qualifiers instruments, spacecraft and suborbital systems, and requalifies reusable carrier electronics. The Branch works closely with flight and ground system developers to ensure that designs are compatible with test and verification requirements.

570 GUIDANCE, NAVIGATION, AND CONTROL CENTER

The Guidance, Navigation and Control Center (GNCC) provides the skills, vision and leadership in guidance, navigation and control (GN&C) systems, engineering, operations and mission analysis to enable revolutionary Earth and Space Science discovery. The GNCC provides national leadership in aggressively pursuing the development and implementation of innovative, cross cutting GN&C technologies by collaborating with industry, academic and government partners.

The scope of technical disciplines encompassed by the GNCC is broad and includes all aspects of flight dynamics, propulsion, flight mechanics, guidance, navigation and control engineering for space systems, experiments, sub-orbital and launch vehicles. The range of products and service is also broad and requires expertise in skill areas such as advances component design, control system architecture, propulsion design, trajectory analysis, autonomy and mission design.

Functional responsibilities include the conceptual and detailed design, development and qualification of advances GN&C technologies for space mission sponsored by NASA, universities, government and commercial partners. Support the entire spectrum of GN&C systems ranging from micro-class spacecraft and instruments to large on-orbit facilities. The GNCC developed innovative GN&C products that are smaller, are lower cost, enable autonomous operations, improve systems performance and use streamline processes. The expertise cultivated from the GN&C research and development efforts fosters commercialization and technology transfer.

Provides technical oversight, evaluation, and consultation to NASA, universities, government agencies, and commercial entities, on GN&C systems development and operations. These efforts include membership on design review teams, anomaly review boards, failure analysis teams, and technical evaluation panels.

Provides flight dynamics products, services and expertise to NASA, government, university, and commercial flight mission. It also plans, designs and develops flight and ground systems for space vehicle trajectory and attitude support, while advancing the state-of-art in flight dynamic to meet future customers needs.

Provides national leadership in the development of advanced GN&C component technologies that enable current and future GN&C systems. Specifically, the GNCC leads the development of new guidance, navigation and control system sensors, actuators, propulsive devices and their interfaces to support space vehicle and instrument design and development.

571 GN&C SYSTEMS ENGINEERING BRANCH

The GN&C Systems Engineering Branch is to serve as the focus of systems level efforts related to GN&C systems within the GN&C Center. As such, the branch will be the initial point of contact and primary interface for customers requiring GN&C engineering services. The branch will be source of control system expertise and will provide leadership in the integration of analytical, hardware, and software disciplines into flight-worthy GN&C systems. Conceptual designs of GN&C control systems will be created and evaluated by analysis and simulation. A primary function of the branch is to ensure the training and development of engineers with a high level of systems engineering expertise in anticipation of the future needs of GSFC. GN&C responsibilities performed at Goddard's Wallops Flight Facility will be managed within this branch.

572 FLIGHT DYNAMICS ANALYSIS BRANCH

The Flight Dynamics Analysis Branch is responsible for providing Guidance, Navigation and Control analytic expertise for all trajectory and attitude systems. This includes the performance of dynamics and control analyses and simulation of launch and space vehicles. The Branch creates and maintains state-of the art analysis tools for mission design, trajectory optimization, orbit analysis, navigation, attitude determination, and control analysis. The Branch synthesizes strategies and algorithms for trajectory guidance and attitude control systems for launch vehicles and spacecraft that satisfy mission requirements. The Branch assesses by analysis and simulations the stability, robustness, and performance of trajectory guidance and attitude control systems for both orbital and sub-orbital launch systems and spacecraft.

573 COMPONENTS AND HARDWARE SYSTEMS BRANCH

The Components and Hardware Systems Branch is responsible for the development of advances GN&C component technologies that enable current and future GN&C systems. Specifically, the GNCC leads the development of new guidance, navigation and control system sensors, actuators, propulsive devices and their interfaces to support space vehicle and instrument design and development. These activities include conducting market surveys, making sensors and/or actuator build or buy recommendations, procuring or designing and building sensors and/or actuators along with providing their associated GSE. The Branch provides, maintains, and manages the component test facilities for both conventional and advanced components to validate their performance while also providing and maintaining an inventory of components. The Branch is chartered with conceiving, analyzing, designing, building, and testing GN&C unique electronics and hybrid dynamic simulators, and supporting integration, test, and validation of these

574 PROPULSION BRANCH

The Propulsion Branch provides engineering expertise in spacecraft propulsion subsystem, design, analysis, fabrication, assembly, integration, test, and launch an post launch operations, including spacecraft propellant loading. The branch provides expertise in fluid systems in support of propulsion subsystem efforts, including test equipment and ground support equipment. it also provides engineering management, procurement technical support, performance evaluation, and anomaly assessment of flight projects for spacecraft propulsion subsystems and expendable launch vehicle propulsion systems. The branch conducts performance evaluation of sub-orbital class launch vehicle propulsion systems and provides chemical analyses and test in support of propulsion related efforts.

The Propulsion Branch defines next generation propulsion technology requirements, and analyzes, developments, test, and integrates advanced propulsion system technologies. This involves collaborating with GN&C customers and stakeholders at assure effective interchange of information and coordination of propulsion technology programs. The branch specifies, procures, and test propulsion components to meet mission and/or advance technology requirements. To that end, the branch operates the Propulsion Test Site to evaluate e propulsion and fluid components, including providing precision cleaning of plumbing and providing residual gas analyses.

580 INFORMATION SYSTEMS CENTER

The Information Systems Center (ISC) is a center of experience and innovation in the implementation and integration of information systems, which at GSFC are used to develop and/or support NASA programs and projects. Core capabilities include development and integration of both information system components and end-to-end information systems, with specific focus of GSFC's three major areas or responsibility - Earth Science, Space Science and cutting-edge Technology. The ISC collaborates with the science community and other customers to meet their information systems needs through providing technology, expertise, capability and products in systems design, development, implementing and test. ISC expertise includes the following information technology areas:

Mission/Project Support Areas

- Mission Planning, Control & Monitoring
- Information Systems Integrating & Test
- On-board flight software & flight software testbeds
- Attitude & Orbit predication and determination systems
- Data capture, processing, management, and distribution systems
- Space craft and instruments telemetry processing
- Simulator for testing of subsystems, systems, and procedures to verify flight readiness
- Acquisition data/network systems
- Advanced data visualization (mission ops applications)
- Performance modeling and capacity planning for science data processing systems
- Automation/autonomy technologies
- Operation support and anomaly investigation for orbiting spacecraft

Science Support Areas

- Data Archiving
- Mass storage and data retrieval
- High performance science computing and parallel processing
- Advanced data visualization
- Image analysis and processing system
- Data mining and data compression

General Information Technologies

- Human Computer Interaction
- Software engineering methods and environments
- System engineering tools
- Advance information systems architecture and standards
- Artificial Intelligence

The ISC provides leadership and vision in identifying and sponsoring new and emerging information systems technologies. These cross-cutting technologies are specifically aimed at enabling future science missions, reducing mission cost, enhancing data processing and product dissemination, and simplifying mission design, development and operation. The ISC will archive this through the close collaboration and leveraging of resources within GSFC, other NASA Centers, other Government Agencies, academia, and industry. Technology validation will be achieved through demonstration in testbeds, technology demonstration flights, and science mission insertion. The ISC vision is to be a sought-after provider of information systems' technology and expertise; demonstrated through technology innovation/assessment/forecasting/integration, quality customer service, and cost-effective/flexible solutions.

581 SYSTEMS INTEGRATION AND ENGINEERING BRANCH

The Systems Integration and Engineering Branch provides end-to-end engineering of ISC mission systems development activities. Branch personnel participate in teams with flight projects, principal investigators, other AETD centers and other organizations to perform their functions. Branch personnel focus on the totality of ISC mission products for particular missions from early spacecraft definition through launch and early orbit support. System interfaces, including ground/flight interfaces, are refined and clarified via trade studies, technical reviews, engineering and operation planning and ensures early involvement of flight operations team personnel to enable routine consideration or end-product science and operations user needs, plus readiness of flight operation personnel for launch support. Branch personnel plan, coordinate and take responsibly for the end-to-end integration and systems test of mission systems. Pre-launch end-to-end simulations of launch and early orbit scenarios are coordinated by this branch to ensure launch readiness of ISC systems. Branch personnel also provide consulting services to customers as needed.

582 FLIGHT SOFTWARE BRANCH

The Flight Software Branch provides life-cycle embedded software products for spacecraft, science instruments and special purpose hardware components. Branch personnel also develop high fidelity dynamic simulation products required for flight software validation. The Branch performs its work in collaboration with the Electrical Systems Center; the Guidance, Navigation, and Controls Center; and the Instrument Technology Center of the AETD; plus the various ground systems and operations planning branches within the Information Systems center. Additional collaboration occurs with other NASA and government agencies; commercial partners and universities.

Branch personnel perform end-to-end flight software systems engineering and flight software systems management of selected missions. In this context the branch participates including in hardware definitions of the flight data systems and components. Branch personnel provide software requirements analysis, design, implementation, test and FSW validation plus mission-life sustaining engineering for flight software and associated flight software testbed systems. Branch personnel also provide selected flight software verification and validation services focusing on operational scenarios during pre-launch activities. Flight software systems engineering strives for advancements in operations ground/ flight interfaces, on-board autonomy, flight software and tools reuse, plus testbed adaptability. Design of flight software products for reuse and the utilization of commercially available products and tools are encouraged to reduce flight program risks, costs, schedules, or complexities. Advanced flight software prototypes may be developed as proof of a concept applicable to future missions. Commercialization of in-house developed flight software products is supported through technology transfer programs.

583 MISSION APPLICATIONS BRANCH

The Mission Applications Branch develops operational mission data systems to support Earth and space science missions. Branch personnel participate in teams with flight projects, principal investigators, other AETD centers, and other appropriated organizations to develop systems for operational off-line mission support. The system include such items as command management systems, spacecraft mission planning and scheduling aids, science planning and scheduling aids, guidance navigation and control, and the ground and space network data systems Branch personnel provide system engineering, system planning, conceptualization, requirements analysis, design implementation, verification and mission-life sustaining engineering for its products. Branch products include assemble COTS systems, customer capabilities, components,

consulting and brokering on behalf of customers. Branch products include assemble COTS systems, customer capabilities, components, consulting and brokering on behalf of customers. Branch personnel apply state-of-the art technologies and COST products to develop cost -effective data systems to meet the customers' needs. The branch performs prototyping in collaboration with other NASA and government systems and related technologies. In addition, the branch developed testbeds to prove concepts in an operational environment. It assist in transferring and commercializing technology developments to industry, other government agencies and academia as appropriate.

584 REAL-TIME SOFTWARE ENGINEERING BRANCH

The Real-Time Software Engineering Branch develops operational mission data systems to support Earth and space science missions. Branch personnel participate in teams with flight projects, principal investigators, other AETD centers and other organizations to develop integrated hardware and software systems for operational real-time support. The system functionality includes spacecraft and instrument integration and test, operational spacecraft commanding Branch personnel provide system engineering, system planning, conceptualization, requirements analysis, design, implementation, verification and mission-life sustaining engineering for its products. Branch products include assemble COTS systems, custom capabilities, components, consulting and brokering on behalf of customers. Branch personnel apply state-of-the -art technologies and COTS products to develop cost-effective data systems to meet customers' needs. The branch performs prototyping in collaboration with other NASA and government organizations, universities, and commercial partners to advance the state-of-the-art in implementation of its functions and related technologies. In addition, the branch develops testbeds to prove concepts in an operational environment. It assists in transferring and commercializing technology development to industry, other government agencies and academia as appropriate.

585 COMPUTING ENVIRONMENTS AND TECHNOLOGY BRANCH

The Computing Environments and Technology Branch provides a diverse variety of tools and services in support of Information Systems Center (ISC) activities. The branch develops and supports computing environments (from workstations to supercomputers) and related technologies that help enable the study of space and Earth science. Branch personnel sustaining the ISC computing and network infrastructure, develop and integrate advance tools which enable efficient project management, support configuration of mission and science control centers, sustain a repository and associated evaluation of technologies, products and services that can meets ISC customer needs, and continually explore and apply

new information technologies. The branch plans, installs, configures and sustains hardware and software systems and testbeds to be used by all of ISC. The branch provides consulting and brokering services to its customers. The branch works closely with vendors to become experts on the use of various Commercial-Off-the Shelf (COTS) tools and to be able to understand the tradeoffs associated with these products. The branch provides World Wide Web (WWW) consultation services and aggressively pursues outreach to schools and universities, Branch personnel also actively pursue the transfer and commercial of related technology to industry, others government agencies and academia.

586 SCIENCE DATA SYSTEMS BRANCH

The Science Data Systems Branch develops and/or provides consultative services for developing data systems to support Earth and space science missions. Branch personnel team with flight projects and principal investigators in the Earth and Space Sciences Directorate to develop systems for operational data capture, level zero and higher level data processing, and data archival, distribution and information management. The systems process various levels of science and telemetry data starting from the point the data reach the ground until they are delivered to scientific users for analysis. The systems may range in complexity from those that handle single, small instrument data-streams with limited user communities to multi-mission, distributed data systems serving diverse multi-disciplinary user communities.

Branch personnel provide system engineering, system planning, and conceptualization, requirements analysis, trade-off studies, consulting and brokering on behalf of customers, prototyping, design, development, verification and mission-life sustaining engineering for its products. Branch products include integrated commercial off-the-shelf (COTS) systems, custom capabilities, and individual system components. Branch personnel apply state-of-the-art technologies, COTS, and government-developed tools (GOTS) to develop cost-effective data systems to meet the customers' needs. The branch performs prototyping in collaboration with other NASA and government organizations, universities, and commercial partners. It develops testbeds to prove concepts in an operational environment. It assists in transferring and commercializing developed technology to industry, other government agencies and academia as appropriate.

587 ADVANCED DATA MANAGEMENT AND ANALYSIS BRANCH

The Advanced Data Management and Analysis Branch serves as its principal customers, the Earth and Space science enterprise, by exploring and developing

creative information technologies and data analysis systems for meeting mission critical requirements. This work is critical for improving the efficiency and effectiveness and reducing the cost of the techniques and systems used to develop information from the massive digital libraries of Earth and space science data. The Branch works closely with the science community in defining requirements, designing solutions, consulting, exploring innovative technologies, prototyping, testbed development, and building products with and for its customers, including both software and integrated hardware/software solutions. Branch personnel partner with customers from the Goddard science directorates, the university community, other NASA and government organizations, and commercial enterprises to competitively respond to funding opportunities.

Key technology areas are data visualization including image processing, virtual reality and animation, information fusion, data mining, data compression, and dynamic query management. Science research software, algorithm development, science data bases, mass storage of science data, science information query and retrieval, and multi-mission and multi-discipline data analysis systems range from small, single instrument analysis systems with a small number of users, to the large, multi-mission and multi-discipline data analysis systems that allow access of many data sets to the entire science community. The Branch produces concepts and prototypes that can be used to support mission engineering, design, development, and operation, and evaluations of Commercial-off-the-Shelf (COTS) and Government-developed tools (GOTS), infusing these where appropriate to ensure capability or to reduce the cost of future missions. The Branch assists in transferring and commercializing developed technology to industry, other government agencies and academia as appropriate.

588 ADVANCED ARCHITECTURES AND AUTOMATION BRANCH

The Advanced Architectures and Automation Branch explores and infuses advances software technologies into next generation mission management and information systems with the objective of reducing cost, improving operational performance and increasing quality science research. The primary focus is the exploration and application of technology to space-ground automation (e.g., lights-out) system and advance software and data system architectures. Key technologies foci are artificial intelligence, distributed systems and human-computer interaction. Branch members produce concepts, prototypes and tools that can be used to support mission engineering, design, development, and operations as well as evaluations of relevant COTS and GOTS, the Branch performed its work through collaborations partners. The Branch actively pursues and assists in the transfer and commercialization of the advanced technologies.